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January 21, 1999

HAND DELIVERY

Ms. Magalie Roman Salas
Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

Re: Ex Parte Presentation

Notice of Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996

CC Docket No. 98-146

Dear Ms. Salas:

In accordance with Section 1.1206(b)(1) of the Commission's rules, enclosed on behalf of @Home Network are an original and two copies of @Home's analysis of two technical papers submitted in the above-captioned docket. Copies of the attached analyses were also provided to the staff indicated below.

Sincerely,

Howard J. Symons

Howard J. Symons

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cc: Robert Pepper
Dale Hatfield
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Analysis of MindSpring Enterprises, Inc.'s "Using cable modems to provide multiple-carrier networks"

@Home Network

The document "Using cable modems to provide multiple-carrier networks," by MindSpring Enterprises, Inc., proposes a system to implement third party access to cable networks. While parts of this filing are technically correct, many parts are inaccurate. Further, MindSpring has glossed over much of the actual complexity of cable data networks. In fact, it is not obvious how to implement multiple-provider access, and MindSpring's filing sheds little light on the topic.

The MindSpring proposal is inadequate in a number of ways. First, it inappropriately compares cable modem networks to Ethernet networks, attempting to demonstrate openness. Second, MindSpring's proposal attempts to use existing technology, such as DHCP and IP routing, in inapplicable ways. Third, it creates an unmanageable situation in which multiple ISPs can easily affect each others' network performance such that the deployment of advanced, managed applications and voice telephony via the cable network is significantly impaired if not impossible.

Cable Modem Networks are NOT Ethernets

MindSpring's proposal compares cable modems to Ethernet networks "in order to understand just how easy it is to use cable modems to provide subscribers access to multiple network operators."[1] Unfortunately, this analogy is overreaching. Although virtually every LAN and MAN technology in use today uses IEEE 802 framing (e.g. FDDI, Ethernet at various speeds, ATM with LAN Emulation), use of such framing does not mean that each of these technologies is functionally the same as Ethernet/IEEE 802.3. The Ethernet framing techniques are used in DOCSIS/MCNS to provide a common interface to Customer Premises Equipment. However, differences abound - the Media Access Control (MAC) protocol specified with MCNS is different enough from Ethernet to create an emerging business in MCNS-compliant chipsets by providers not providing Ethernet chipsets today.

In section 2.1 of the document, MindSpring also proposes techniques for supporting multiple ISPs on a pure layer-2 network. While the document makes this sort of network architecture appear to be commonplace and easy to provide multiple-ISP services over, equipment vendors do not build such equipment and MSOs do not deploy such equipment. DOCSIS modems are not pure layer-2 devices, and the DOCSIS CMTS

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[1] Section 1.

(Cable Modem Termination System) deployed in @Home's 18 partner MSO networks do not support a pure layer-2 environments.

In fact, using pure layer-2 networks for providing public network services has been repudiated by all major CMTS vendors because of serious scalability and management concerns. Moreover, "denial of service" attacks launched by subscribers against other subscribers are common on these systems, and are very hard to police. Several well publicized outages in some earlier @Home markets that use intelligent layer-2 switching were the direct result of this type of denial of service problem, and all layer-2 devices, as a result, have been targeted for replacement with DOCSIS architecture modems. Additionally, this environment blends all multicast domains of the service providers together, eliminating practical use of IP multicast technology on a network infrastructure that is otherwise very friendly to it.

Router Based Cable Networks

MindSpring also suggests methods to "provide multiple access on a hybrid layer-2 / layer-3 network," but omits some important details. Unlike the local telephone network, which consists of a set of dedicated loops, the cable network is a shared medium and requires care to prevent interference between subscribers and services and to assure fair access to network resources. The ability for an MSO to deliver the appropriate capacity and latency to network providers is essential to support viable business relationships with these ISPs.

Also, in section 2.2, the proposal suggests "cable network providers can blindly route traffic based on originating IP address to the appropriate upstream router for final routing." However, this approach is not specified by any Internet standard for IP routing. The Internet standards require that routers select paths based on the Destination IP Address.

Because destination-based routing is the standard way of forwarding packets, router vendors optimize their equipment for it. All router vendors have a "fast path," usually implemented in hardware, for normal routing, and a slower software forwarding path for "exceptional" conditions. Source-based forwarding is usually a slow-path forwarding process, if it is implemented at all. Most vendors do not even implement support for source-based forwarding, including several who build router based CMTSs. Slow path forwarding of source-based packets will result in network performance degradation and significant scaling problems.

The implementation of MindSpring's proposal, therefore, would depend on the cable MSOs convincing router vendors to develop new, special routers, at increased expense and time. Moreover, MindSpring's proposal would require the industry to move away from the use of standard telecommunications equipment throughout the Internet. Only in the past couple of years has the industry been able to leverage the broad telecommunications manufacturing base, rather than rely instead on cable-centric manufacturers, because of Internet based cable network standards like DOCSIS. This has supported much greater competition amongst vendors, and the ability to leverage development being done for the Internet as a whole. This has significantly reduced costs and improved both performance and features for MSOs and consumers alike. Requiring special features such as source based routing would reverse these gains.

Even if source based routing were universally required by Internet industry standards and implemented by many manufacturers, problems would still exist. One specific example of a problem with source-based routing is that it creates complications for IP Multicasting. IP Multicasting is a standard technology for sending information from one or more sources to one or more receivers, without broadcasting the traffic to all possible receivers. The proposed source-based routing solution only addresses unicast IP traffic. For many broadcast applications, such as stock tickers, video broadcasts, Internet radio, and push technology, IP multicasting is much more efficient, and necessary to scale to millions of subscribers. Source based routing systems would be incompatible with the use of multicast technology by multiple ISPs.

Other Issues in MindSpring's Proposal

A multiple ISP system is very problematic in DOCSIS based systems because conflicts occur in managing:

- Address Space: There is no neutral enforcement mechanism in DOCSIS /MCNS to handle multiple address ranges. Ensuring traffic from the Internet arrives back at the subscriber's computer via the designated ISP requires non-overlapping address ranges that likely must belong to that ISP's global routing prefix. Most if not all Ethernet "multiple address ranges on the same wire" implementations are done within the same management domain (e.g. the same company) and in the same prefix for purposes particular to that domain (e.g. to transition from one address space to another).

  This is further complicated by the issues surrounding the combination of the optical nodes in an HFC plant, and its effects IP network topology when connected to upstream and downstream modem interfaces in CMTSs. IP address space management for both the subscriber cable modems (CMs) and their associated PCs must be provisioned consistently with the physical topology of the plant and CMTS network interfaces. This requires very tight coupling between the ISP's provisioning service elements and the physical wiring in the headend and CMTS configuration, and is further complicated when renumbering of user's computer and CM must occur due to changes in node combining equipment when capacity in the market is being increased.

- MCNS Security: MCNS standard security mechanisms have centralized control points, such as the Cable Modem Termination System (CMTS) and the DHCP server. They do not support distributed control, with each ISP having its own control mechanisms. Access list configuration in CMTSs, for example, is not designed to support distributed or shared control, and misconfiguration compromises subscriber security. While a cable operator could manually attempt to configure such information after resolving potential conflicts from ISPs it supports, large numbers of such access lists introduce performance problems in the router, and would not be practical in large scale deployment.

- DHCP: The MindSpring proposal relies upon Dynamic Host Configuration Protocol, but does not describe DHCP operation precisely. In particular, for DHCP to work dependably at a large scale, there will need to be a single DHCP server for any given piece of CMTS equipment. The DHCP standards do not specify how multiple ISPs could have competing DHCP servers on the same IP subnet, and given the current protocol design, it is improbable that the current implementations could be made to work in this mode. Even if one could somehow interconnect diverse ISP back-office systems with a MSO DHCP server, it would be difficult to reliably prevent one ISP from interfering with another ISP or the other ISP's customers (for example, by providing a DHCP entry that refers to another ISPs customer maliciously or by accident).

- Shared Bandwidth: With telephone modems, one customer cannot interfere with another customer's connection to the RAS. With cable modems, one customer can interfere with another customer's connection to the CMTS equipment. The problems of competitive interference with access to upstream bandwidth are severe and fundamental to the nature of the cable plant because of its shared architecture. Moreover, there is a very limited amount of upstream bandwidth, and the location and number of upstream channels will vary dynamically over the course of a day. Problems also exist on the downstream path. While some prioritization and resource control mechanisms do exist, the ability to allocate the network bandwidth on an ISP "pool" basis does not. Being able to allocate total system capacity into such pools by ISP is critical in supporting real-world service level agreements with ISPs. Otherwise, one ISP's users could swamp the HFC plant capacity and deny service to another ISP's customers.

- OSS functions: The paper totally fails to address essential functionality required to support an ISP business over the cable plant, such as provisioning of services, access by customer service agents of ISPs to real-time HFC plant and CM status, traffic engineering and management, dispatch and trouble ticket interfacing between the ISP and the MSO, network fault isolation and troubleshooting, network capacity expansion, CM software updating and modification, etc. All current cable Internet service businesses rely on these subsystems to actually operate and service customers. Focusing purely on transport related issues is naïve, and will not yield practical system designs that will allow mass market service rollout.

Conclusion

The MindSpring proposal reflects a basic misunderstanding of cable network design and operation, and equipment capabilities and standards. Its proposed "solutions" rely on unavailable equipment and introduce unsolved problems that flow from impractical system designs. CMTSs that operate at layer-2 have proven to be hard to scale and manage; similarly, source-based routing is non-standard, and will undoubtedly raise scalability problems. Finally, the basic design is intrinsically flawed. It creates a system in which multiple ISPs compete for bandwidth and other resources, with little or no ability for the cable operator to be successful in meeting its commitments to ISP or voice telephony customers.

The DOCSIS specification was designed to support as simple a system architecture as could practically meet the needs for a scaleable rollout of Internet based data services. There was no consideration given to the support of multiple ISPs operating on top of the cable system, as this was not required by regulation, nor was it consistent with the business plans of most MSOs. DOCSIS has done an excellent job of meeting its core design objectives, however, and is being supported by many manufacturers worldwide, including major consumer electronics companies, and will shortly be entering widespread retail distribution. Imposing on cable operators the obligations proposed by MindSpring would fragment a currently unified vendor base, increasing cost and prohibiting effective retail distribution, just as major rollouts have commenced and vendors are in large scale production.

Analysis of "TPRIA Point of Interconnect Network Design"

@Home Network

"TPRIA Point of Interconnect Network Design," by Tekton Internet Associates, proposes a system to implement third party access to cable networks. Based on the considerable experience of @Home Network, the largest cable-based provider of Internet access, the solution proposed, although theoretically correct in some parts, is inadequate to support the deployment of service on a scale sufficient to meet mass-market subscriber levels.

Specifically, we believe that the solution falls short in four key areas. First, it inappropriately constrains subscribers in their usage of broadband Internet service. Second, it raises the cost of providing service to customers beyond the ranges required to support broad, mass-market adoption. Third, it relies on unproven technologies that impact the system's ability to scale. Lastly, the proposal creates an unmanageable situation in which the conflicting interests of multiple providers are aggregated onto a single platform, without adequate means for resource allocation and conflict resolution. The consequence of this final factor could impair not only the provision of Internet service to customers, but also the provision of voice telephony offered over the @Home Network facilities.

These problems remain, despite Tekton's attempts to sidestep the challenges by assigning almost all of them to the Cable Network Operator. Specifically, under Tekton's proposal, the CNO provisions the cable modems; configures the Cable Modem Termination System (CMTS); manages the address space; configures the Point Of Interface (POI) router; purchases and maintains the network equipment; provisions the DHCP server; manages the cable modems and other network equipment; responds to ISP service demands; provides and maintains a customer management system; and resolves service level disputes among ISPs. In fact, Tekton imposes only a single task on the ISP: the ISP merely provides a circuit into the demarcation point, and IP dial tone to the subscriber. This approach is unlike the dialup case, in which the ISP actually purchases and maintains its own modem banks, address space, POI router, DHCP server, and customer and service management systems. In practical effect, Tekton's proposal is akin to an arbitrary unbundling of a business, rather than a serious technical proposal to unbundle the cable network. Under these circumstances, it is difficult to discern the value the ISP is actually providing by participating in the network.

The Proposed Design Limits Subscriber Choice and Customer Usage of Broadband Internet Services

Although the proposal assumes, without any evidentiary support, that "...each Subscriber will access the service from just one PC,"[1] this is not consistent with @Home's experience. The most frequently requested service from @Home subscribers has been for multiple IP service. This demand is currently driven by multiple PCs, and will only accelerate over time as people add Internet appliances, including smart-phones, set-top boxes, video-conferencing gear, and the like. Tekton's proposal nevertheless would arbitrarily restrict the offering of broadband Internet service by relying on a technical approach that would not permit the provisioning of multiple IP devices within a single home. This result would, in our view, severely curtail one of the key benefits that broadband Internet will bring to the American consumer.

The proposal also makes another assumption that impacts data-over-cable subscribers. Because it "relies on the ability of the Subscriber's PC to function as a DHCP client,"[2] the proposal may eliminate as much as 10-15 percent of home-based computers (non-Windows and non-Macintosh machines), which cannot function as DHCP clients. Devices designed to be always connected, such as the upcoming broadband set-top, will benefit from a fixed IP address that enables them to serve local data and to act as receivers for incoming IP voice and video calls. It is for this reason that @Home currently offers fixed IP addresses for its subscribers and believes that it would be a mistake to force fully dynamic DHCP usage.

Third Party Access Significantly Raises the Costs of Providing Data Services

Despite the Tekton's claim that "Standard practice today is to use the MAC addresses, and this document assumes that practice,"[3] @Home's current policy for over 300,000 subscribers is to use client IDs. The use of client IDs de-couples the customer's purchase of a new PC, NIC card, or other home network device, from the information retained by the service provider. This, in effect, removes much of the customer care costs borne whenever a subscriber replaces an edge device. Using the MAC address solution proposed would mean expensive customer service calls every time a new device is added or an existing one has its hardware configuration modified.

The proposal also erroneously claims that "ARP requests are intercepted and answered by the CMTS."[4] Actually, this is incorrect for all versions of DOCSIS. ARP requests *may* be proxied by the CMTS, but the CMTS will send ARP requests to its associated Cable Modems and the subscriber CPE if the CMTS does not have the requested address cached. The CMTS is not required to intercept ARPs, but some implementations do.

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[1] Section 4.1

[2] Section 4.3

[3] Section 5.6.4

[4] Section 5.9

Similarly, the assertion that "The POI router maintains an ARP table used to send each packet to the appropriate subscriber"[5] does not work if the CMTS is a routing CMTS rather than a bridging CMTS, and either is allowed by DOCSIS. In the routing case, the POI router may need host specific routes for each subscriber CPE - possibly tens of thousands of routes. It is possible each route would have to be individually configured by the CNO as part of the subscriber provisioning process.

Together, these mistaken assumptions about CMTS behavior mean that implementation of the proposed solution could require the replacement of tens of millions of dollars of headend CMTS gear, with compliant hardware. The deployment delay, management and compatibility overhead, and additional costs would delay the rollout of broadband services and raise their cost.

The New Network Design Relies on Unproven Technology and is Difficult to Scale

The Tekton solution relies upon a technique known as a source-based routing,[6] in which an IP packet's source address is a factor in determining the destination. This technique, although nominally implemented in some networking gear, is non-standard and has never been widely deployed on the Internet. There is very little operational experience using source routing, and analysis has cast doubt on the validity of deploying and scaling a large network on the basis of source-based routing.

Part of the issue is standard router design. Because destination-based routing is the standard way of forwarding packets, router vendors optimize their equipment for it. All router vendors have a "fast path," usually implemented in hardware, for normal routing, and a slower software forwarding path for "exceptional" conditions. Source-based forwarding is usually a slow-path forwarding process, if it is implemented at all. Most vendors do not even implement support for source-based forwarding, including several who build router based CMTSs. Slow path forwarding of source-based packets will result in network performance degradation and significant scaling problems.

Over time, this approach would require the cable MSOs to convince router vendors to develop special routers, at increased expense and time, and cause the industry to have to move away from the use of standard telecommunications equipment used throughout the Internet. Only in the past couple of years has the industry been able to leverage the broad telecommunications manufacturing base, instead of cable-centric manufacturers because of Internet based open cable network standards like DOCSIS. This has supported much greater competition among vendors and the ability to leverage development being done for the Internet as a whole. This has significantly reduced costs and improved both

[5] Section 6.2.1

[6] Section 5.4

performance and features for MSOs and consumers alike. Requiring special features such as source based routing would reverse these gains.

One specific example of the problem with source-based routing is that it creates complications for IP multicasting. IP multicasting is a standard technology for sending information from one or more sources to one or more receivers, without broadcasting the traffic to all possible receivers. The proposed source-based routing solution only addresses unicast IP traffic. For many broadcast applications, such as stock tickers, video broadcasts, Internet radio, and push technology, IP multicasting is much more efficient, and necessary to scale to millions of subscribers.

The Inclusion of Multiple ISPs Results in Resource Conflict

Unlike the local telephone network, which consists of a set of dedicated loops, the cable network was never designed to be shared by multiple providers, and therefore resembles a single, high-speed bus. In such a situation, it is not surprising that the presence of multiple ISPs creates potential for conflict, abuse, and misallocation of resources. This conflict not only would impair the Internet services provided by the multiple ISPs, but also degrade the provision of telephony service over the common cable plant.

For example, it is virtually impossible to properly allocate resources in a multiple ISP environment. Neither the DOCSIS1.0 nor the DOCSIS 1.1 specifications include enough tuning knobs to ensure that any given "group" of subscribers gets a particular aggregate level of service. While the knobs *may* allow the appropriate control of a specific customer (and this is by no means clear), it would be virtually impossible to provide real-time fairness guarantees between multiple groups of subscribers. The CNO would find itself trying to mediate fair bandwidth allocation on a second-by-second basis between customers of multiple ISPs and it would fail in such an effort.

A related issue arises with the addressing plan.[7] The plan proposes that "customer ISPs will provide the CNO with blocks of world routable IP addresses..." Unfortunately, every CMTS has a hard limit on the number of address blocks that it can have assigned to it. This implies that the allocation of block slots to specific ISPs is yet another resource that must be managed by the CNO. This can result in one ISP locking out another ISP on a particular CMTS by consuming all the block slots.

The complete process of provisioning a customer and keeping the customer operational is split across the CNO and the ISP, and can be affected by a third party (another ISP being serviced by the same CNO). The correct operation of the system from the subscriber's point of view is dependent on the ISP and the CNO being in and staying in synchronization with respect to the information they both maintain about the subscriber. The CNO would have to provide a customer management system that provided each

[7] Section 5.3.1

associated ISP with a view of the system that included that ISP's customers and no others, even though those others could impact the provisioning activities of the ISP.

In general, then, the proposal describes a system with fairly fragile interfaces between the participants, and plenty of opportunities for mismanagement and poor coordination. In such a system, each ISP will have the incentive to consume as much as possible as quickly as possible, without regard to the welfare of the entire system.

Conclusion

Proposing third-party access to the cable plant is far easier than implementing it. Simply put, these proposals require unproven technology that will almost undoubtedly cause scaling problems for high bandwidth residential cable networks. They create an environment in which subscribers cannot deploy new and more numerous devices onto the network. They raise customer care and deployment costs. Finally, they create a resource allocation and management nightmare that the cable plant was never designed to deal with and that would impede the deployment of telephony services over this plant. Together, these solutions will inevitably raise the price of broadband services while simultaneously stalling or delaying their rollout.